# Responses of Vegetation to Grazing by White-Tailed Deer *Odocoileus virginianus*

Progress Report #2

Studies carried out from 1992-1993 at Point Pelée National park and at other sites in Southern Ontario

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# PREFACE

In 1992, Point Pelée National Park staff initiated a 2 year study by York University in which the impact of deer grazing on the park vegetation was to be investigated in order to determine how best to monitor grazing pressure. Point Pelée was one of 11 sites studied as part of a joint project undertaken by Dawn R. Bazely, Assistant Professor, Biology Department, York University and Dennis R. Voigt, Deer Research Biologist, Ontario Ministry of Natural Resources, in which we aimed to determine the overall impact of herbivory by white-tailed deer in Southern Ontario, with particular emphasis on Carolinian zone vegetation. This project was to be the M.Sc. research of Saewan Koh. His M.Sc. thesis was initially planned to investigate the impact of deer grazing at both the plant community (woody and herbaceous) level and at the level of the individual plant species. In Report 1 submitted to Point Pelée in January 1993, we reported on results from

(1) studies of *Trillium grandiflorum* at all sites in the wider study and

(2) herbaceous plant community composition at Point Pelée compared with the nearby Hillman Sandhills site.

In the present report we give details of stand structure for woody species at Point Pelée and Hillman Sandhills as well as results from seed bank studies at these sites and at Rondeau Provincial Park. However, it is important to note that Saewan's M.Sc. thesis will contain only the results of studies on three spring flowering genera, *Trillium*, *Arisaema* and *Viola*. This is because it became apparent to both the student and his M.Sc. supervisory committee (D. R. Bazely, D. R. Voigt and D. J. McQueen) that he had collected such a vast amount of data that the plant community part of the study was best incorporated into a Ph.D. thesis! Thus, the M.Sc. thesis, of which Point Pelée will receive a copy, will only contain data on the growth and population biology of individual species and how they respond to deer herbivory.

It should also be noted that in 1994 the study has broadened considerably in its scope, both at Point Pelée and at Rondeau and Pinery Provincial Parks. We are now looking at (1) vegetation recovery from overgrazing by deer, (2) long-term monitoring of vegetation, (3) control of invasive exotic plant species which may come into sites following overgrazing and subsequent deer culls, and (4) active site restoration.

## ACKNOWLEDGEMENTS

Once again we must thank very many people for their help with this study. We received funding from a wide variety of sources. In particular, we wish to acknowledge Gary Mouland at Point Pelée National Park for his ongoing support and Dennis Voigt at the Ontario Ministry of Natural Resources for all kinds of financial support including the use of OMNR vehicles. Also, we thank the many landowners who have given us access to sites used in the wider study. In 1993 the study was supported by the Environmental Youth Corps Programme of the OMNR through which we hired our field assistants, Maxine Tang and David Lin. Catherine Sykes was another field assistant who was a volunteer from England, from Haberdashers' Aske's Girls' School, Elstree, Herts (Dawn Bazely's old school). Catherine was funded by the School Governor's to work in our lab., through a job shadowing programme, before she started her undergraduate degree in Zoology at Oxford University. At York University, Prof. Don McQueen has provided valuable supervision for Saewan throughout his M.Sc. studies.

## ADDENDUM TO REPORT 1

In 1992 NO *Trillium grandiflorum* were found at Point Pelée. However in the spring of 1994 Maxine Tang and David Lin found a clump of several plants in an isolated location between the northern and southern transects referred to in this report.

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# INTRODUCTION

The Carolinian forest zone of southern Ontario contains 70% of Ontario's rare plant species (Varga & Allen 1990). In recent years intense deer herbivory has caused major shifts in plant community composition in some of the "premier" Carolinian sites such as Point Pelée National Park, and Rondeau and Pinery Provincial Parks (e.g. Koh & Bazely 1992). In some locations, such as Point Pelée and Rondeau, deer culls have taken place to reduce grazing pressure (e.g. Voigt & Smith 1993). At these sites there was concern over whether the ecosystem was able to recover from overgrazing by deer.

In 1991 we undertook a study of the impact of deer browsing and grazing on plant communities in southern Ontario. The overall objective of this wider study was:

**To determine how vegetation responds to deer herbivory across a range of grazing pressures, at 11 sites in Southern Ontario.** (see Koh & Bazely 1992, Koh et al. submitted, for site locations).

At Point Pelée, park staff were particularly interested in developing some sort of index of deer grazing pressure. This complemented the wider study's aims of examining deer herbivory at both the plant community level and the level of individual plant species. In our previous report, we discussed the use of the height of *Trillium grandiflorum* plants as an index of grazing pressure (Koh & Bazely 1992, Koh et al. submitted). We also examined plant biomass at Point Pelée and nearby Hillman Sandhills.

In the studies presented here, we report on the following overall objective:

**To place Point Pelée in the context of other sites, specifically Hillman Sandhills and Rondeau Provincial Park.**

The specific objectives of this report are:

(1) To compare the seed banks of these sites with respect to their native and exotic species composition.

Intense grazing by deer may reduce the capacity of a site for regeneration. Following deer herd reductions, we predicted that we would observe invasions of weedy plant species able to

exploit overgrazed habitats. We also expected to see fewer species in the seed bank of heavily grazed sites.

(2) To compare the structure of the woody plant species (i.e. trees and shrubs) among these sites.

We predicted that size class distributions of trees and shrubs would be variable among sites depending upon past grazing pressure. At Point Pelée we expected to find large numbers of smaller trees and shrubs following release from intense grazing. At intensively grazed sites at Rondeau, we expected to find fewer small and medium sized trees and shrubs.

# METHODS

## Sites

General site characteristics are given in Koh et al. (submitted). Point Pelée was intensively grazed until two deer culls in the early 1990s, whereas Hillman Sandhills has low levels of deer grazing. At Rondeau Provincial Park, deer grazing pressure was high (>45 deer $km^{-2}$) until Fall 1993, when >70% of the population was removed (Voigt & Smith 1993).

## Seed bank Study

Seed bank composition was determined at Point Pelée National Park, Hillman Sandhills and Rondeau Provincial Park. We used a grow-out method, in which turves of soil were collected from these three sites in March-April 1992 and subsequently monitored until November 1993. All emerging seedlings of herbaceous species and graminoids were counted. Once the seedling was identified it was pulled out of the turf.

### Collection and treatment of soil turves

In early March 1992 we plotted a 1 km transect in each of the northern and southern sections of Point Pelée National Park. Four of the 100 m points along the northern transect were randomly selected and six of the 100 m points along the southern transect were randomly selected. At each of the ten locations we cut out a turf of soil 16.5 cm long, 12 cm wide and 5.5 cm deep. We placed each turf in an individually marked plastic tray (flat) and transported the collection to an exclosure near the warehouse area of Rondeau Provincial Park.

In mid-April 1992, we randomly selected ten locations from four 300 m transects at Hillman Sandhills. At each of the locations we cut soil turves of the same dimensions as those cut from Point Pelée. These 10 turves were also placed in marked flats and taken to Rondeau Park.

In Rondeau Provincial Park we collected soil turves from sites with different histories of deer grazing pressure:

A. Deer exclosures built in 1991 and the adjacent grazed sites.

B. Deer exclosures built in 1978 and the adjacent grazed sites.

A. Thirty 2 m x 2 m deer exclosures were built along ten transects in March 1991. Ten exclosures were in dry forest sites (denoted NEXD), ten in mesic sites (denoted NEXM) and ten in wet sites (denoted NEXW) (see Koh 1991 for detailed description). In April 1992 one soil turf was sampled from inside each exclosure (n = 30) and one turf was sampled from outside of each exclosure (n = 30) (denoted as NEX(D/M/W) GR sites).

B. We collected 10 turves from inside each of two large (0.2 ha) exclosures (established in 1978) located off Bennett and Gardiner Roads (denoted as BEX and GEX exclosures) and from the adjacent grazed areas immediately outside the exclosures (n = 20 turves from exclosures, n = 20 turves from grazed (control) sites). Thus, a total of 100 turves were collected from Rondeau.

In 1992 the turves were watered regularly and scored every 3-4 weeks for seedling emergence and identification. We scored the graminoids as a group. The graminoids we scored are presently in the process of being identified to species, if possible,from specimens preserved in plant presses.

In April 1993 we brought the turves to a site outside the greenhouse at York University. We continued to monitor seedling emergence until November 1993.

Data Analysis

Graminoids were removed from our analysis because the many species which may occur in this group have yet to be identified. *Cardamine hirsuta* was also removed from the analysis because we strongly suspect that this species seeded into the experiment in the summer of 1993 at York University. This suspicion is based largely on that fact that the species was not observed at any site outside of York yet it appears in almost all of the turves from all of the sites (We realize that this is anecdotal evidence only).

## Survey of Woody Vegetation

In 1993 we surveyed the trees and shrubs (woody species) at each of the three study sites using a protocol adapted from the bird and vegetation survey conducted in Rondeau Provincial Park in 1991 (Bowles & Gartshore 1992, Gartshore 1994).

At all stations along the transects from which soil turves for the seed bank study were sampled, a 20 m transect (north-south) bisected by a 10 m transect (east-west) was established. The four terminal points and the point at which the transects intersected (where the initial vegetation monitoring site was located) were marked (Figure 1). At each of these five points we measured the distance (metres) to the nearest tree and shrub. From this tree or shrub the distance to the nearest neighbour was measured From this "nearest neighbour" the distance to the next "nearest neighbour" tree or shrub was measured (Figure 1). This method allowed us to sample each site using both a "closest individual" protocol (Figure 1. distance 1 - $d_1$) and a "nearest neighbour" protocol (Figure 1. distances 2 and 3 - $d_2$ and $d_3$) (Mueller-Dombois & Ellenberg 1974). We recorded the species of the trees and shrubs encountered and their diameter at breast height (cm). At each plot 15 individuals were measured in each of the tree and shrub categories.

We defined trees as live woody stems with diameters greater than 7.5 cm at 1.4 m above the ground or in the case of fallen live trees 1.4 m from where the ground would have been if the tree was still standing. We defined shrubs as woody stems that are taller than 0.4 m with a diameter of less than 7.5 cm at 0.4 m from ground level. We did not include dead trees and shrubs. The 20 m north-south/ 10 m east-west transects were set up at ten stations along the major transects at Point Pelée, Hillman and Rondeau. At Rondeau, 10 stations were selected at random from the thirty exclosure stations. Trees and shrubs in grazed sites were measured at each station or plot (designated in the results as NEX GR sites). In addition, 5 stations were selected at random from within BEX (Bennett exclosure at Rondeau) and 5 stations from outside BEX. At the BEX and BEX GR sites we measured trees and shrubs at only the four points at the end of each of the bisecting transects, giving a count of 12 trees or shrubs measured at each plot rather than 15.

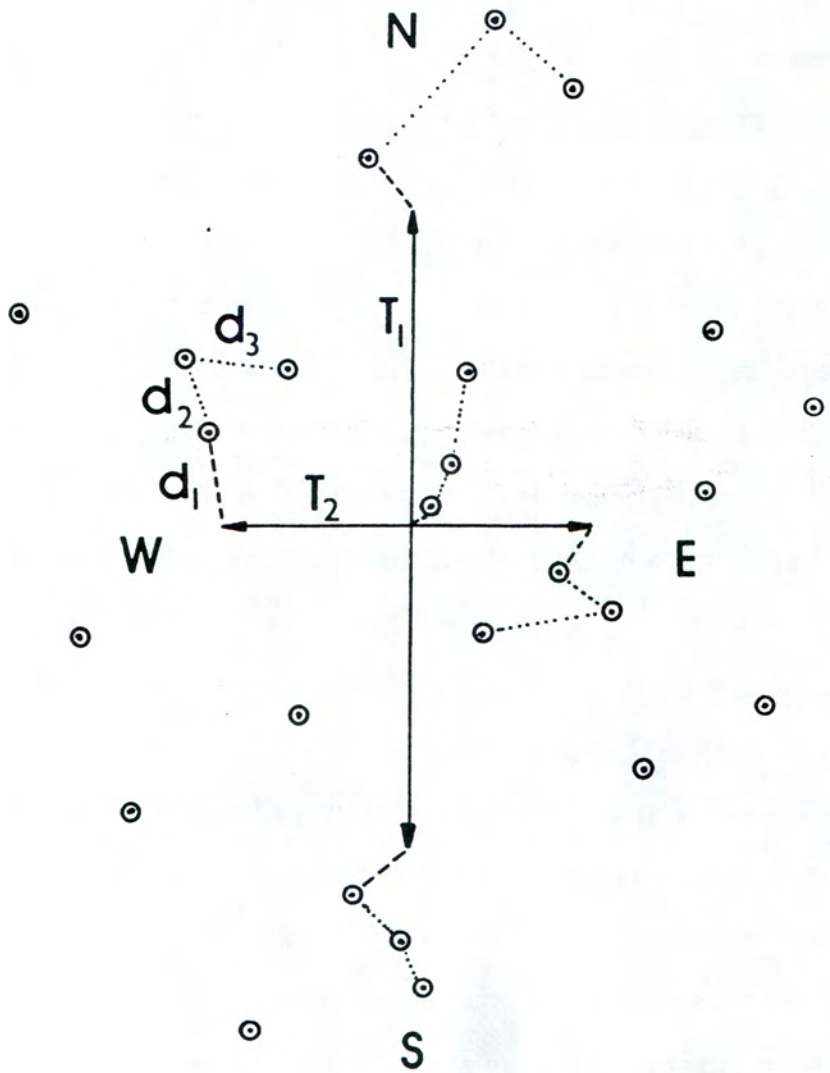


Figure 1. Sampling scheme for woody species. A single sample station or plot is illustrated in which two transects ($T_1$ = 20 m, $T_2$= 10 m) bisect each other. The nearest tree and distance ($d_1$ — — →) to the end of each transect and the point at which the transects intersected was measured. The distance to the nearest tree ($d_2$ ·····) from the first tree was also measured in addition to the distance to the next nearest neighbour ($d_3$ ·····).

# RESULTS

## Seed bank Study

### Native and Introduced Plant Species

The total number of native and introduced (alien/exotic) herbaceous plant species, excluding *Cardamine hirsuta*, occurring in all soil turves collected from each site was calculated (Figure 2). In some cases seedlings could only be identified to genus, and were grouped according to genera, e.g. *Viola*. Therefore we have underestimated the total number of viable species in the seed bank at a site. The total number of species/genera varied from 19 to 35. In general native species tended to comprise the largest proportion (i.e. greater than 66%) of the overall plant species composition at a site. The two exceptions were GEX (Gardiner exclosure, Rondeau) where only 10 of 19 species were native (53%) and Point Pelée where 21 of 34 species were native (61%).

The total number of individual seedlings of each plant species found in all soil turves from each site and the frequency of occurrence of each species in a turf are given in Tables 1-12 in the Appendix. These lists were split up into native and introduced species/groups. The percentage of the total number of individual seedlings which were introduced plant species varied widely among sites (Figure 3). The highest proportion of seedlings of introduced plant species occurred at Point Pelée (85%). The site with the next highest proportion of individuals of introduced species was GEX GR sites (64%). The highest percentage of individuals of native species was found in the seed bank at Hillman Sandhills with 82% of seedlings being from native species. The long-term deer exclosures at Rondeau, GEX (66%) and BEX (80 %), also had a high proportion of native individual seedlings (Figure 3).

### Diversity Indices

A species diversity index was generated for each soil turf using Margalef's diversity index formula (see Appendix) (Magarrun 1988). This index incorporates both richness and distribution of each species (Magarrun 1988). All of the values from a particular site were used to generate a

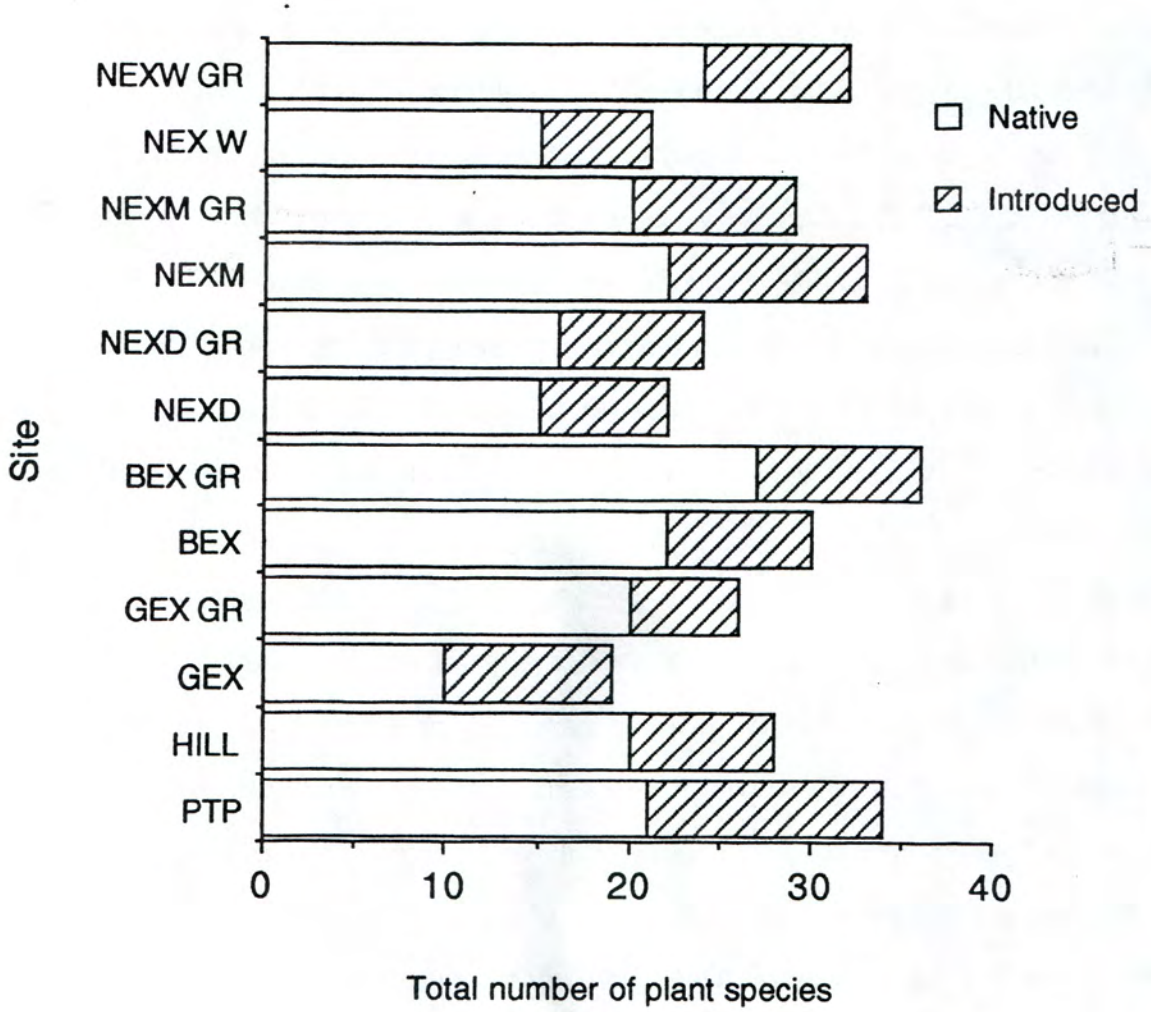


Figure 2. The total number of herbaceous plant species and groups (genera) found in soil turves from Point Pelée (PTP), Hillman Sandhills (HIL) and Rondeau (GEX-NEXW GR sites) from 1992-1993. n = 10 turves collected from each site.

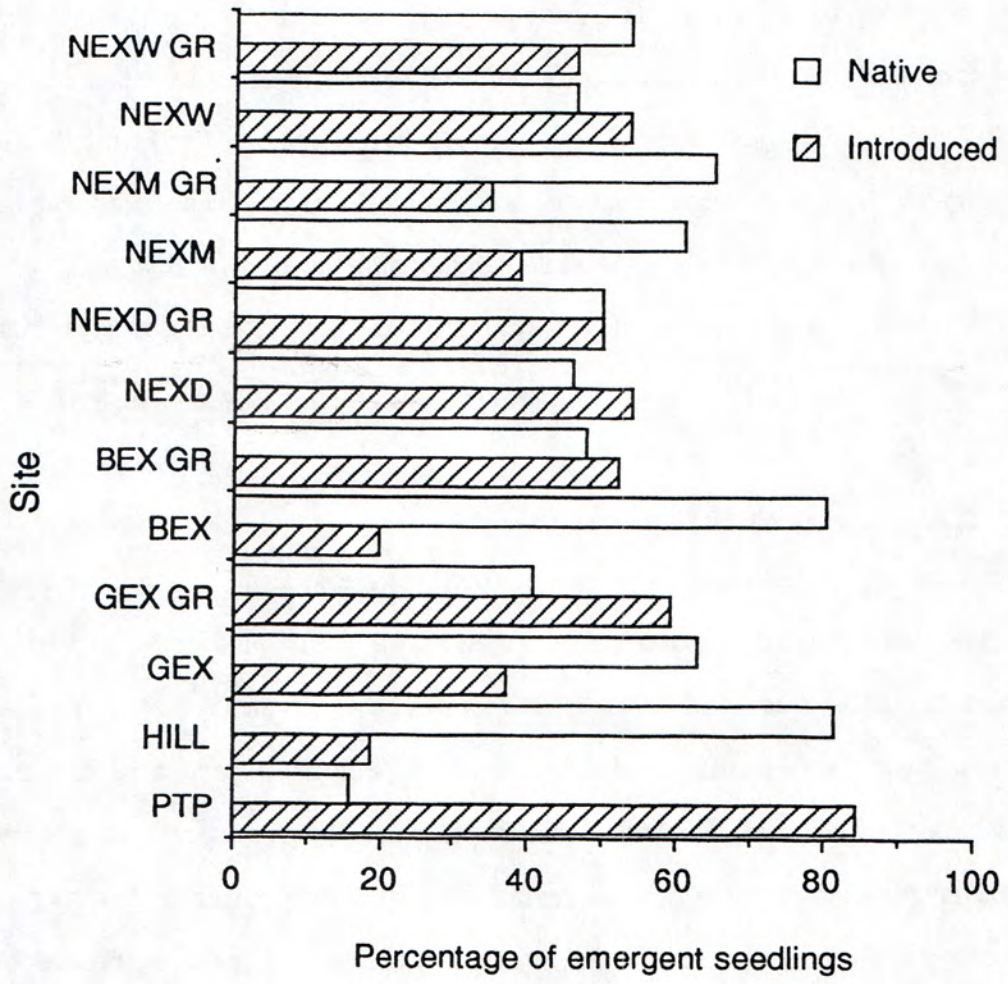


Figure 3. The percentage of seedlings emerging from soil turves grouped into native and introduced species categories. Soil turves collected from Point Pelée (PTP), Hillman Sandhills (HIL) and Rondeau (GEX-NEXW GR sites) and monitored from 1992-1993. n = 10 turves collected from each site.

mean diversity index for that site (Figure 4). A comparison between sites was performed with a one way analysis of variance. There was a significant difference in the diversity index among sites ($F_{11,119}$, $p<0.01$). Point Pelée had one of the highest mean diversity values (2.5) while the 10 plots that make up the Dry forest type at Rondeau had the lowest mean indices at 1.54 and 1.55 for the ungrazed and grazed sites respectively. While not significant, there was a trend for control grazed sites in Rondeau to have lower diversity indices than their adjacent exclosed sites (Figure 4).

Relationship between plant species and area

The mean number of plant species present per turf was greatest at PTP and lowest in NEX sites (Rondeau) (Figure 5) indicating that the plant community at Point Pelée tended to be more homogeneous while that in grazed sites at Rondeau tended to be more heterogenous. We also examined the relationship between the cumulative number of species found occurring in the seed bank and the number of soil turves sampled (Figure 6). This is in effect a "species-area" curve. As expected, the greater the number of turves sampled, the greater the number of plant species found. When only 10 turves were sampled, there was considerable variation in the number of species found within a site. Within grazed sites such as PTP (#2) and BEX GR + GEX GR there tended to be more species found than in ungrazed sites (e.g. GEX - #12) (Figure 6). Clearly, the greater the sampling intensity or area sampled at a site, the greater the number of species that will be found in the seed bank. However, in evaluating these data, the distribution of individuals of different species (Figure 3) must be kept in mind.

## Survey of Woody Vegetation

For the purpose of this report we present basic information on size classes of trees and shrubs and diversity indices. Data are currently being analysed for dominance and density statistics. These analyses will be included in S. Koh's Ph.D. thesis.

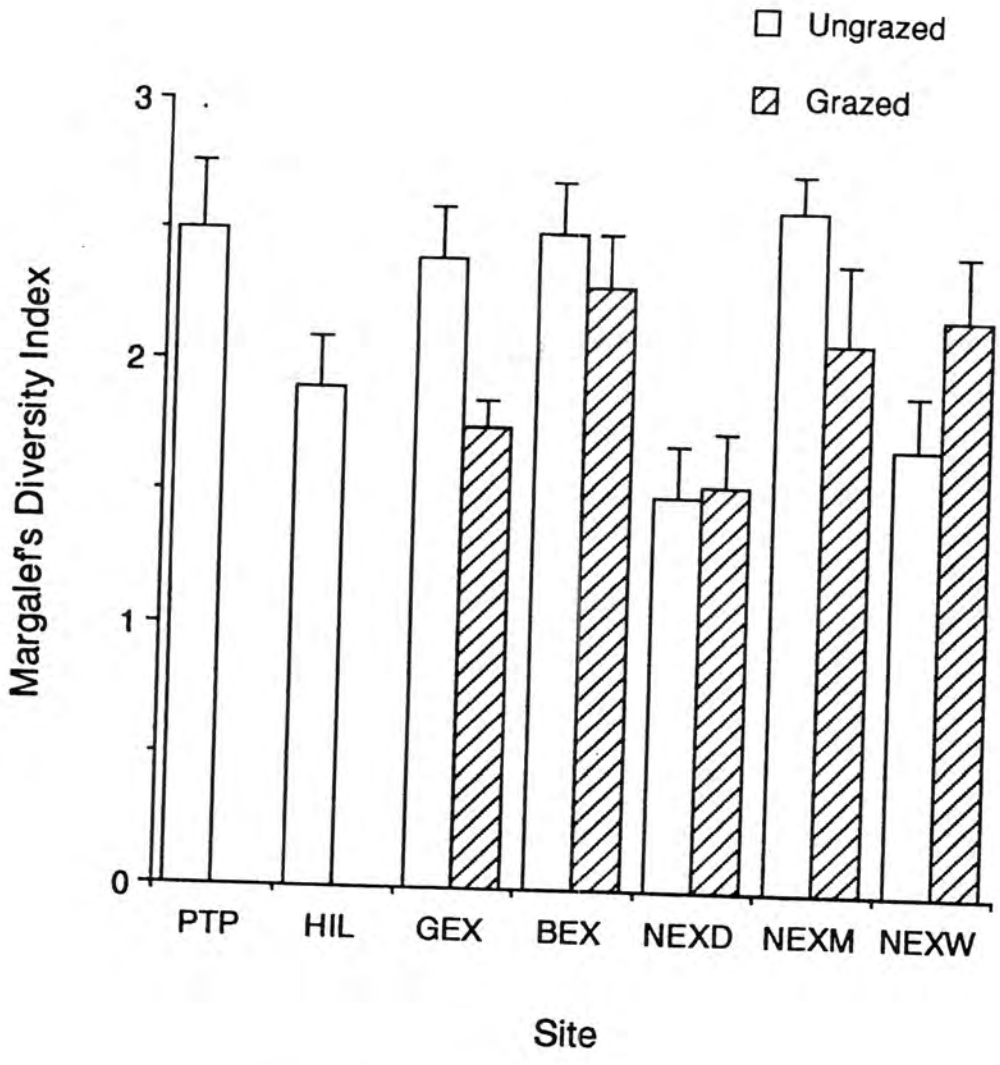


Figure 4. Margalef's Diversity Indices for seedbank study. Soil turves collected from Point Pelée (PTP), Hillman Sandhills (HIL) and Rondeau (GEX-NEXW GR sites) and monitored from 1992-1993. n = 10 turves collected from each site.

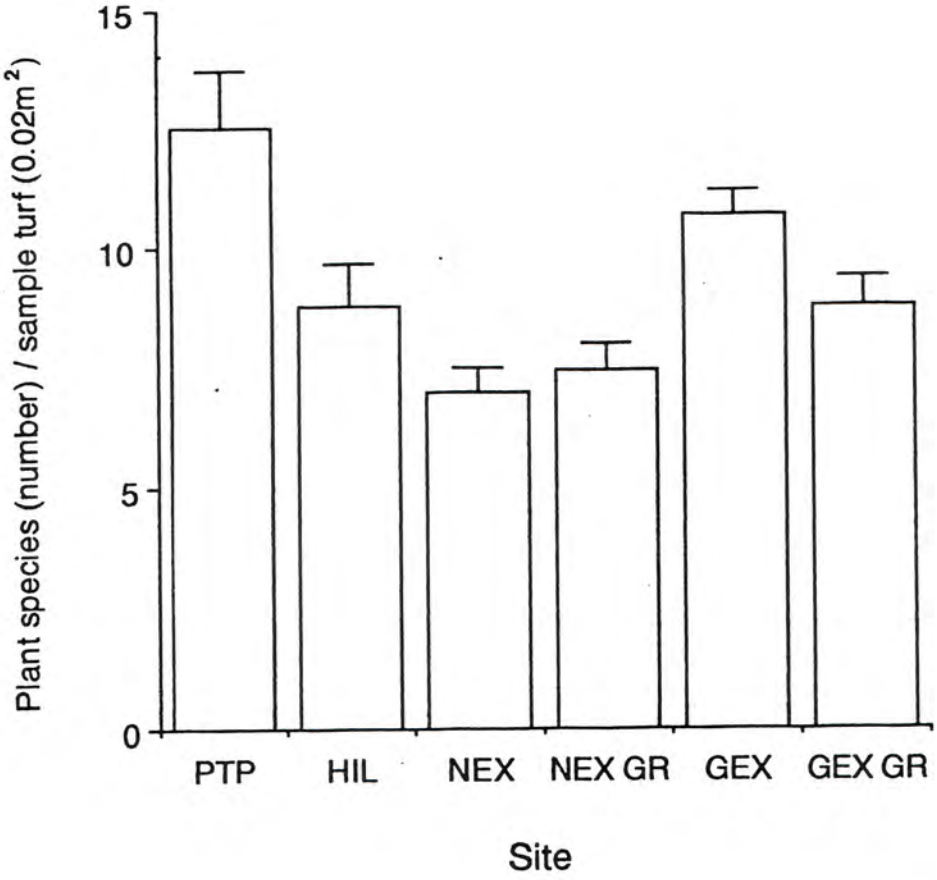


Figure 5. Mean number of plant species (and genera groups) observed per soil turf (0.02 $m^2$ area) in the seedbank study. Soil turves collected from Point Pelée (PTP), Hillman Sandhills (HIL) and Rondeau (NEX-GEXW GR sites) and monitored from 1992-1993. n = 10 turves collected from each site.

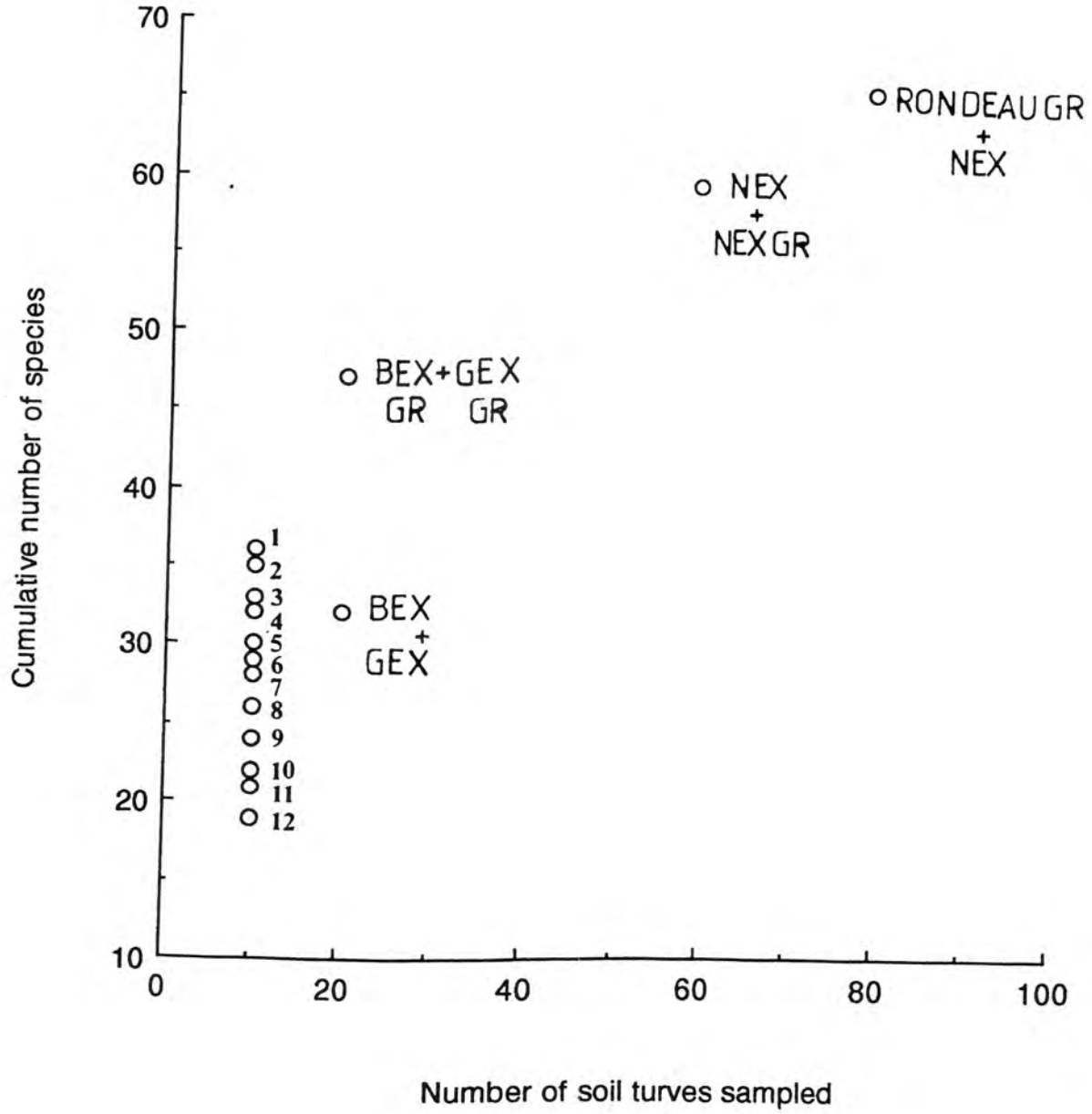


Figure 6. Cumulative number of species versus number of soil turves sampled in the seedbank study. 1 = BEX GR; 2 = PTP; 3 = NEXM; 4 = NEXW GR; 5 = BEX; 6 = NEXM GR; 7 = HIL; 8 = GEX GR; 9 = NEXD GR; 10 = NEXD; 11 = NEXW; 12 = GEX. The Rondeau GR designation includes all of the grazed sites at Rondeau (outside NEX, BEX and GEX) as well as NEX sites which were exclosed in 1991.

Species composition

The total number of shrub species did not vary greatly among sites (Figure 7a). We identified 10 species of shrub at both Point Pelée and Hillman, and 11 shrub species at Rondeau. The total number of tree species was more variable among sites, with Rondeau having the greatest number (19 tree species) (Figure 7a). In terms of species distribution, at each stations (consisting of 5 sample points) we found on average 3 to 5 species (Figure 7b).

The dominant species in each of the sites differed for both shrub and tree categories (see Tables 13-22 in the Appendix). At Point Pelée the dominant species was quite obvious. *Celtis occidentalis* L. occurred in all 10 plots sampled and made up 62% of all trees sampled. In contrast, at Rondeau the dominant tree, *Fagus grandifolia*, occurred at 8 sampled plots and made up only 27% of all individual trees sampled (see Tables 13-17 in the Appendix).

Diversity Indices

Margalef's diversity indices were calculated for the populations of trees and shrubs measured at each site (Figure 8). Analysis of variance indicated that while tree diversity varied significantly among sites ($F_{2,28}$, $p< 0.05$), shrub diversity did not ($F_{2,28}$, $p= 0.26$) (Figure 8). The diversity of tree species was lowest at Point Pelée, and highest at Rondeau. Hillman Sandhills had the highest diversity index for shrubs while Point Pelée had the lowest.

Diameters of trees and shrubs

Distributions of tree diameters were skewed to the 8 cm-20 cm ranges at all sites (Figures 9a-e). Distributions of shrub diameters were more varied among sites (Figures 10a-e). At Hillman Sandhills and Rondeau, shrubs tended to be evenly distributed among all size classes. At Point Pelée however, the frequency histogram for shrubs was skewed towards the 0-1.5 cm diameter size class.

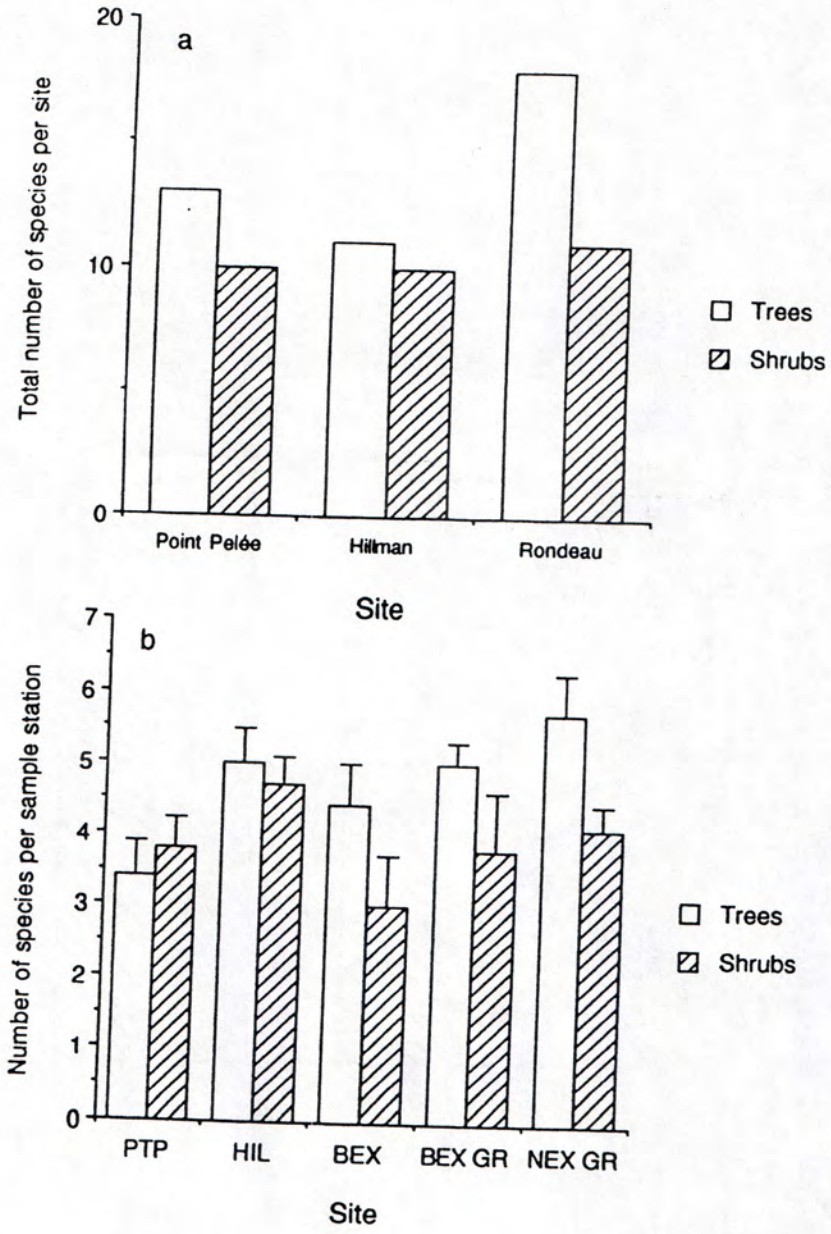


Figure 7. a. The total number of woody species occurring at 10 sample stations at Point Pelée, Hillman Sandhills and Rondeau (excluding BEX and BEX GR sites)

b. Mean number of woody species per sample station at Point Pelée (PTP), Hillman Sandhills (HIL) and Rondeau (BEX -NEX GR sites).

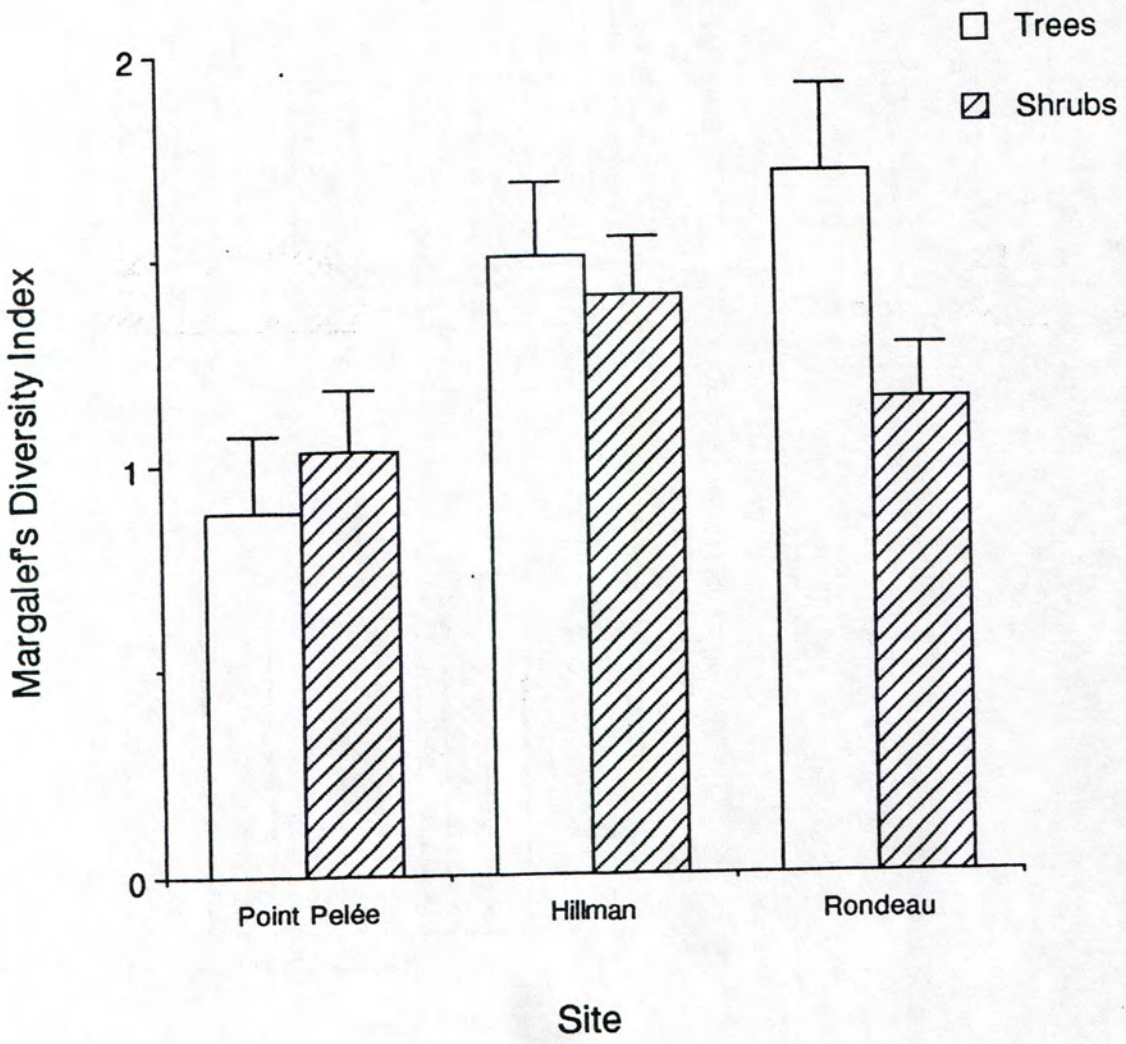


Figure 8. Margalef's Diversity Indices for woody species at Point Pelée, Hillman Sandhills and Rondeau (excluding BEX and BEX GR sites).

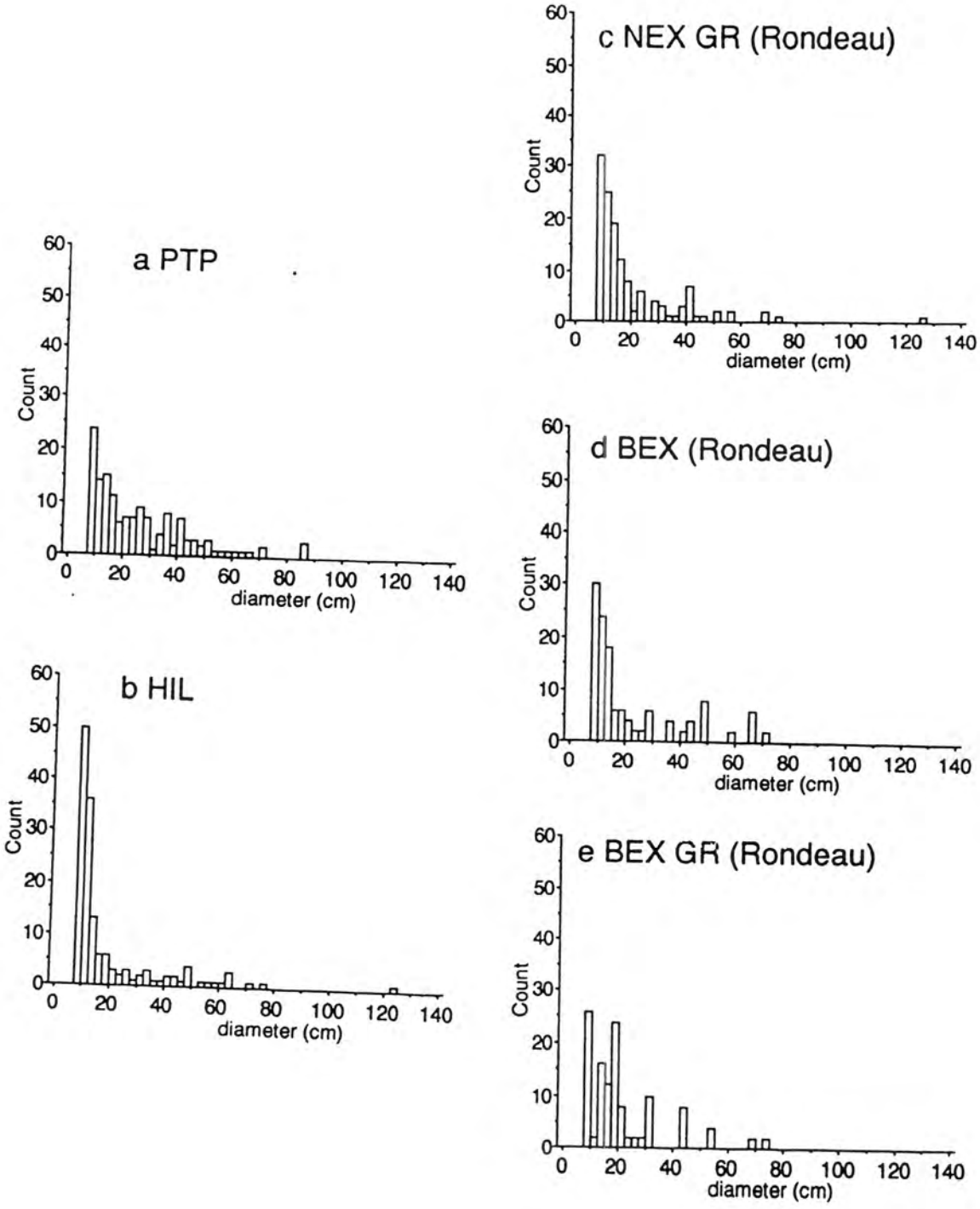


Figure 9. Distribution of size classes of trees at different sites.

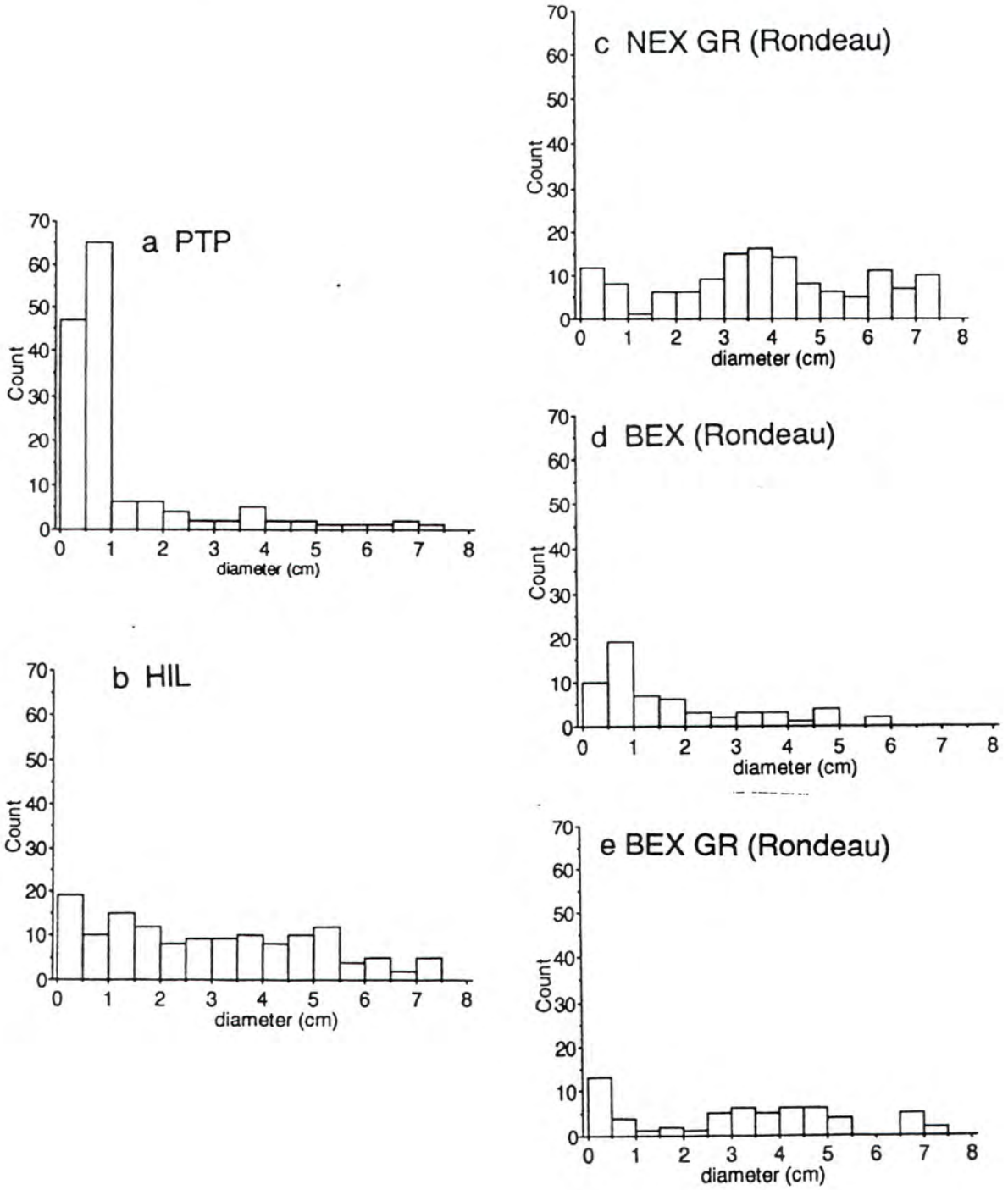


Figure 10. Distribution of size classes of shrubs at different sites.

# DISCUSSION

## Seed bank Study

The results of the seed bank experiment indicate that a number of attributes relating to species diversity must be kept in mind when evaluating "biodiversity" at a site. They also indicate that heavy grazing by deer in the past may have had a significant negative impact on the seed bank and potential for recovery of herbaceous vegetation at Point Pelée. Point Pelée had one of the highest diversity indices for herbs in the seed bank study. However, when the proportion of germinating individuals of native species was compared to that of introduced species, it was apparent that the high diversity index was caused primarily by introduced (non-native) plant species. Fewer than 19% of seedlings in soil turves from Point Pelée were native. This compares quite poorly with two other sites: Hillman with a less severe grazing history and Rondeau which was heavily grazed up to 1993-94. The pattern for Hillman, where intense grazing has not occurred in the past 20 years, was the reverse of that at Point Pelée: at Hillman, native species comprised over 80% of the total number of seedlings. At Rondeau, sites which have recovered from intense deer grazing e.g. BEX and GEX also had a high proportion of individuals of native species while adjacent grazed areas tended to be dominated by introduced plant species.

Why do more intensely deer grazed sites have higher proportions of introduced plant species? This may either be because deer tend to preferentially graze native plants or because introduced species are more grazing tolerant. Previous research (Koh & Bazely 1992, Koh et al.) indicates that native spring-flowering species such as *Trillium* do not withstand intense grazing. Saewan Koh's M.Sc. thesis (due for completion in September 1994) compares and contrasts the life histories of grazing tolerant and intolerant native species. Species able to survive in intensely grazed sites tend to be weedy, producing many seeds, frequently have anti-herbivore defences, or they have indeterminate within-season growth. In addition at Point Pelée, following the deer culls, the introduced species with a "weedy" or "r-selected" life history may have been able to invade overgrazed habitats. It remains to be seen whether this pattern will be observed at Rondeau or

whether the higher proportion of native plant species in the soil bank will allow the vegetation to recover more rapidly without introduced species becoming dominant.

Since many of the plant communities designated as "Carolinian" vary in species composition, it may be that one of the best ways to assess deer impact at any particular site is to use groups of native and introduced species as indicators. As we have shown in the preliminary analyses of these data, the most heavily grazed sites may be expected to have a ratio of introduced species to native species that is skewed towards the introduced species. Less severely affected sites will have less biased ratios. Changes in this ratio in terms of plant species occurring at a site may serve as an early warning of ecosystem damage. Changes in the species composition of the seed bank as observed in soil cores may show decrease in the potential of a site to recover from heavy grazing, and would serve as a later warning signal. However, our results were encouraging because in spite of past heavy deer grazing at both Point Pelée and Rondeau, a surprisingly high number of native plant species were present (see Appendix Tables for lists).

## Survey of Woody Vegetation

Rondeau Provincial Park had the highest diversity of trees among all three sites. At all Rondeau habitats (NEX GR, BEX GR and BEX) we found relatively few large trees and evidence of regeneration in terms of numbers of trees in the the smaller size classes. The most interesting finding was that unlike other sites, most of the shrubs at Point Pelée were in the smallest size classes (0-1 cm) diameter. This most likely represents release from deer grazing following the recently culls. We expect the pattern to be similar at Rondeau in the next two years.

## General conclusions

This report contains only a very preliminary analysis of part of a much larger dataset. General findings to date, in this and in our previous report (Koh & Bazely 1992) are:

1. Intense deer grazing has resulted in the loss of a number of native spring-flowering species from sites such as Point Pelée and Rondeau parks.

2. Intense deer grazing has resulted in major shifts in the herbaceous plant community composition at these sites.

3. The composition of the seed bank in terms of the ratio of native/introduced herbaceous plants is highly variable among sites. Simply listing species present is not enough - the numbers of individuals must also be monitored.

4. The amount of woody vegetation (shrubs and small trees) at Point Pelée is increasing following release from intense grazing.

5. At all sites studied, trees of large diameter (>50 cm dbh) were rare. This probably reflects past logging practices.

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# APPENDIX

Margalef's Diversity Index was calculated as:

$$D = (S - 1)/\ln N$$

S = the number of species recorded

N = the total number of individuals summed over all species

For a discussion of various diversity indices see Magurran 1988.

Table 1. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= 0.2m$^2$ ) collected at Point Pelée.

| Native plant species and groups | | | Introduced plant species and groups | | |
|---|---|---|---|---|---|
| | Presence (% of sites sampled) | # of seedlings /0.2m$^2$ | | Presence (% of sites sampled) | # of seedlings /0.2m$^2$ |
| graminoids | 40 | 61 | Stellaria media | 10 | 805 |
| Geranium robertianum | 40 | 61 | Alliaria officinalis | 70 | 85 |
| Viola spp. | 80 | 40 | Cerastium vulgatum | 80 | 47 |
| Osmorhiza claytoni | 50 | 31 | Taraxacum officinale | 80 | 43 |
| Pilea pumila | 30 | 10 | Parthenocissus quinquefolia | 10 | 24 |
| Rubus idaeus | 30 | 7 | Cardamine hirsuta | 60 | 22 |
| Thalictrum dioicum | 30 | 7 | Veronica arvensis | 30 | 19 |
| Solidago spp. | 50 | 6 | Chenopodium album | 10 | 12 |
| Geum spp. | 40 | 5 | Aster lowrieanus | 30 | 10 |
| Galium triflorum | 20 | 4 | Solanum nigrum | 10 | 7 |
| Veronica peregrina | 30 | 4 | Veronica chamaedrys | 30 | 4 |
| Campanula americana | 30 | 3 | Glechoma hederacea | 30 | 3 |
| Viola pensylvanica | 30 | 3 | Sonchus arvensis | 10 | 1 |
| Phryma leptostachya | 20 | 3 | | | |
| Sabatia angularis | 10 | 3 | | | |
| Viola papilionacea | 20 | 2 | | | |
| Ranunculus abortivus | 20 | 2 | | | |
| Eupatorium rugosum | 20 | 2 | | | |
| Polygonatum biflorum | 20 | 2 | | | |
| Toxicodendron radicans | 10 | 1 | | | |
| Physalis heterophylla | 10 | 1 | | | |

Table 2. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= $0.2m^2$ ) collected at Hillman Sandhills in spring 1992.

| Native plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | Introduced plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
|---|---|---|---|---|---|
| Rubus idaeus | 100 | 212 | Cardamine hirsuta | 90 | 92 |
| graminoids | 90 | 185 | Cerastium vulgatum | 60 | 34 |
| Ranunculus abortivus | 50 | 45 | Taraxacum officinale | 70 | 17 |
| Viola spp. | 30 | 9 | Aster lowrieanus | 30 | 10 |
| Solidago spp. | 70 | 8 | Veronica arvensis | 20 | 4 |
| Erythronium americanum | 20 | 6 | Solanum nigrum | 20 | 3 |
| Circaea quadrisulcata | 20 | 5 | Chenopodium album | 20 | 2 |
| Podophyllum peltatum | 20 | 5 | Veronica chamaedrys | 10 | 1 |
| Oxalis montana | 20 | 4 | Alliaria officinalis | 10 | 1 |
| Maianthemum canadense | 10 | 3 | Galium aparine | 10 | 1 |
| Phryma leptostachya | 10 | 2 | | | |
| Aquilegia canadensis | 10 | 1 | | | |
| Eupatorium rugosum | 10 | 1 | | | |
| Parthenocissus quinquefolia | 10 | 1 | | | |
| Polygonum scandens | 10 | 1 | | | |
| Viola sororia | 10 | 1 | | | |
| Viola papilionacea | 10 | 1 | | | |
| Rubus spp. | 10 | 1 | | | |

Table 3. Species of seedlings ranked in order of frequency of emergence from n =10 turves (total area= $0.2m^2$ ) collected at NEX D sites at Rondeau Provincial Park in spring 1992.

| **Native plant species and groups** | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | **Introduced plant species and groups** | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
|---|---|---|---|---|---|
| graminoids | 80 | 219 | Cardamine hirsuta | 60 | 105 |
| Lysimachia ciliata | 10 | 25 | Taraxacum officinale | 90 | 25 |
| Galium spp. | 40 | 6 | Stellaria media | 30 | 14 |
| Thalictrum dioicum | 20 | 5 | Aster lowrieanus | 10 | 12 |
| Vitis aestivalis | 10 | 5 | Cerastium vulgatum | 50 | 12 |
| Viola pensylvanica | 10 | 5 | Veronica arvensis | 50 | 8 |
| Viola spp. | 20 | 4 | Sonchus arvensis | 30 | 3 |
| Solidago spp. | 20 | 3 | | | |
| Aquilegia canadensis | 10 | 2 | | | |
| Polygonatum biflorum | 20 | 2 | | | |
| Maianthemum canadense | 10 | 2 | | | |
| Rubus idaeus | 10 | 1 | | | |
| Cardamine pensylvanica | 10 | 1 | | | |
| Galium circaezans | 10 | 1 | | | |
| Osmorhiza claytoni | 10 | 1 | | | |

Table 4. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= $0.2m^2$ ) collected at NEXD GR sites at Rondeau in spring 1992.

| **Native plant species and groups** | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | **Introduced plant species and groups** | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
|---|---|---|---|---|---|
| graminoids | 70 | 218 | Cardamine hirsuta | 100 | 164 |
| Veronica peregrina | 10 | 12 | Taraxacum officinale | 70 | 19 |
| Thalictrum dioicum | 30 | 10 | Veronica arvensis | 40 | 17 |
| Galium spp. | 20 | 5 | Cerastium vulgatum | 50 | 10 |
| Maianthemum canadense | 10 | 3 | Stellaria media | 30 | 3 |
| Aquilegia canadensis | 30 | 3 | Veronica chamaedrys | 10 | 1 |
| Vitis aestivalis | 10 | 3 | Berberis thunbergii | 10 | 1 |
| Rubus idaeus | 20 | 3 | Verbascum thapsus | 10 | 1 |
| Solidago spp. | 20 | 3 | | | |
| Boehmeria cylindrica | 20 | 2 | | | |
| Cardamine pensylvanica | 20 | 2 | | | |
| Viola pensylvanica | 10 | 2 | | | |
| Eupatorium rugosum | 10 | 1 | | | |
| Rudbeckia fulgida | 10 | 1 | | | |
| Viola spp. | 10 | 1 | | | |
| Galium triflorum | 10 | 1 | | | |

Table 5. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= 0.2m$^2$ ) collected at NEXM sites at Rondeau in spring 1992.

| Native plant species and groups | Presence (% of sites sampled) | # of seedlings /0.2m$^2$ | Introduced plant species and groups | Presence (% of sites sampled) | # of seedlings /0.2m$^2$ |
|---|---|---|---|---|---|
| graminoids | 50 | 21 | Cardamine hirsuta | 50 | 63 |
| Rubus ideaus | 60 | 17 | Plantago major | 40 | 19 |
| Viola spp. | 60 | 14 | Taraxacum officinale | 70 | 11 |
| Oxalis montana | 40 | 13 | Cerastium vulgatum | 40 | 7 |
| Pilea pumila | 40 | 9 | Sonchus arvensis | 40 | 5 |
| Solidago spp. | 40 | 7 | Chenopodium album | 10 | 4 |
| Galium triflorum | 10 | 6 | Parthenocissus quinquefolia | 10 | 3 |
| Galium spp. | 20 | 5 | Aster lowrieanus | 10 | 3 |
| Galium aparine | 10 | 3 | Veronica arvensis | 20 | 3 |
| Cardamine douglassi | 10 | 2 | Solanum nigrum | 20 | 2 |
| Boehmeria cylindrica | 20 | 2 | Stellaria media | 20 | 2 |
| Impatiens capensis | 10 | 2 | | | |
| Acalypha rhomboidea | 10 | 2 | | | |
| Polygonatum biflorum | 20 | 2 | | | |
| Geranium maculatum | 10 | 2 | | | |
| Erigeron annuus | 10 | 1 | | | |
| Eupatorium rugosum | 10 | 1 | | | |
| Cardamine pensylvanica | 10 | 1 | | | |
| Erigeron pulchellus | 10 | 1 | | | |
| Trillium spp. | 10 | 1 | | | |
| Viola pubescens | 10 | 1 | | | |
| Viola pensylvanica | 10 | 1 | | | |

Table 6. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= $0.2m^2$ ) collected at NEXM GR sites at Rondeau in spring 1992.

| Native plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | Introduced plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
|---|---|---|---|---|---|
| graminoids | 90 | 107 | Cardamine hirsuta | 50 | 47 |
| Rubus idaeus | 40 | 25 | Taraxacum officinale | 70 | 20 |
| Galium spp. | 50 | 13 | Cerastium vulgatum | 50 | 10 |
| Oxalis montana | 30 | 11 | Plantago major | 30 | 7 |
| Viola spp. | 50 | 11 | Solanum nigrum | 30 | 6 |
| Solidago spp. | 40 | 5 | Stellaria media | 10 | 2 |
| Impatiens capensis | 10 | 4 | Berberis thunbergii | 10 | 1 |
| Vitis aestivalis | 20 | 3 | Sonchus arvensis | 10 | 1 |
| Boehmeria cylindrica | 20 | 2 | Aster lowrieanus | 10 | 1 |
| Eupatorium rugosum | 20 | 2 | | | |
| Arisaema triphyllum | 20 | 2 | | | |
| Acalypha rhomboidea | 10 | 2 | | | |
| Lindera benzoin | 10 | 2 | | | |
| Circaea quadrisulcata | 10 | 1 | | | |
| Galium aparine | 10 | 1 | | | |
| Sambuca racimosa | 10 | 1 | | | |
| Pilea pumila | 10 | 1 | | | |
| Trillium spp. | 10 | 1 | | | |
| Phryma leptostachya | 10 | 1 | | | |
| Galium triflorum | 10 | 1 | | | |

Table 7. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= $0.2m^2$ ) collected at NEXW sites at Rondeau in spring 1992.

| Native plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | Introduced plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
|---|---|---|---|---|---|
| graminoids | 70 | 163 | Cardamine hirsuta | 50 | 46 |
| Pilea pumila | 60 | 16 | Taraxacum officinale | 80 | 42 |
| Floerkea proserpinacoides | 20 | 7 | Sonchus arvensis | 50 | 15 |
| Geum spp. | 10 | 6 | Cerastium vulgatum | 10 | 2 |
| Viola spp. | 40 | 6 | Urtica dioica | 10 | 1 |
| Ranunculus abortivus | 20 | 4 | Stellaria graminea | 10 | 1 |
| Trillium spp. | 10 | 4 | | | |
| Rubus idaeus | 20 | 2 | | | |
| Solidago spp. | 20 | 2 | | | |
| Verbena hastata | 10 | 1 | | | |
| Boehmeria cylindrica | 10 | 1 | | | |
| Viola pensylvanica | 10 | 1 | | | |
| Geranium maculatum | 10 | 1 | | | |
| Galium aparine | 10 | 1 | | | |
| Vitis aestivalis | 10 | 1 | | | |

Table 8. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= $0.2m^2$ ) collected at NEXW GR sites at Rondeau in spring 1992.

| Native plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | Introduced plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
|---|---|---|---|---|---|
| graminoids | 70 | 113 | Cardamine hirsuta | 4 | 28 |
| Trillium spp. | 10 | 8 | Sonchus arvensis | 30 | 19 |
| Viola spp. | 50 | 8 | Taraxacum officinale | 90 | 26 |
| Aquilegia canadensis | 20 | 6 | Veronica arvensis | 30 | 7 |
| Cerastium vulgatum | 30 | 6 | Anemone quinquefolia | 10 | 5 |
| Anemone cinquefolia | 10 | 5 | Solanum nigrum | 20 | 4 |
| Polygonatum biflorum | 10 | 5 | Aster lowrieanus | 10 | 1 |
| Vitis aestivalis | 30 | 4 | Stellaria media | 10 | 1 |
| Rubus idaeus | 30 | 4 | | | |
| Galium spp. | 20 | 3 | | | |
| Thalictrum dioicum | 20 | 3 | | | |
| Pilea pumila | 20 | 3 | | | |
| Floerkea proserpinacoides | 10 | 3 | | | |
| Boehmeria cylindrica | 10 | 2 | | | |
| Phryma leptostachya | 10 | 2 | | | |
| Solidago spp. | 20 | 2 | | | |
| Ranunculus abortivus | 20 | 2 | | | |
| Circaea quadrisulcata | 10 | 1 | | | |
| Eupatorium rugosum | 10 | 1 | | | |
| Cardamine pensylvanica | 10 | 1 | | | |
| Galium triflorum | 10 | 1 | | | |
| Galium aparine | 10 | 1 | | | |
| Veronica peregrina | 10 | 1 | | | |
| Rhus radicans | 10 | 1 | | | |

Table 9. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= $0.2m^2$ ) collected at BEX sites at Rondeau in spring 1992.

| Native plant species and groups | | | Introduced plant species and groups | | |
|---|---|---|---|---|---|
| | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
| Dentaria laciniata | 80 | 47 | Cardamine hirsuta | 70 | 286 |
| Rubus idaeus | 100 | 24 | Taraxacum officinale | 90 | 31 |
| Viola papilionacea | 40 | 24 | Solanum nigrum | 40 | 10 |
| Viola spp. | 60 | 24 | Cerastium vulgatum | 40 | 6 |
| graminoids | 60 | 21 | Veronica arvensis | 10 | 4 |
| Cardamine douglassi | 20 | 19 | Chenopodium album | 10 | 2 |
| Pilea pumila | 30 | 12 | Stellaria longifolia | 10 | 1 |
| Cardamine pensylvanica | 50 | 10 | Parthenocissus quinquefolia | 10 | 1 |
| Sambucus canadensis | 10 | 10 | Sonchus arvensis | 10 | 1 |
| Solidago spp. | 50 | 9 | | | |
| Arisaema triphyllum | 40 | 9 | | | |
| Floerkea proserpinacoides | 20 | 7 | | | |
| Oxalis montana | 40 | 6 | | | |
| Maianthemum canadense | 40 | 6 | | | |
| Circaea quadrisulcata | 20 | 4 | | | |
| Aquilegia canadensis | 10 | 4 | | | |
| Geum spp. | 20 | 2 | | | |
| Lindera benzoin | 10 | 2 | | | |
| Thalictrum dioicum | 20 | 2 | | | |
| Boehmeria cylindrica | 10 | 1 | | | |
| Geranium maculatum | 10 | 1 | | | |
| Galium triflorum | 10 | 1 | | | |
| Galium spp. | 10 | 1 | | | |
| Scutellaria lateriflora | 10 | 1 | | | |
| Cardamine pensylvanica | 10 | 1 | | | |
| Trillium spp. | 10 | 1 | | | |
| Sambucus pubens | 10 | 1 | | | |

Table 10. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= $0.2m^2$ ) collected at BEX GR sites at Rondeau in spring 1992.

| Native plant species and groups | | | Introduced plant species and groups | | |
|---|---|---|---|---|---|
| | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
| graminoids | 100 | 166 | Cardamine hirsuta | 80 | 152 |
| Viola spp. | 80 | 25 | Stellaria media | 50 | 62 |
| Floerkea proserpinacoides | 30 | 24 | Veronica arvensis | 30 | 4 |
| Dentaria laciniata | 70 | 14 | Taraxacum officinale | 70 | 30 |
| Cardamine pensylvanica | 50 | 10 | Cerastium vulgatum | 40 | 36 |
| Galium spp. | 20 | 7 | Plantago major | 20 | 5 |
| Bidens connata | 30 | 7 | | | |
| Oxalis montana | 40 | 6 | | | |
| Circaea quadrisulcata | 20 | 5 | | | |
| Galium triflorum | 20 | 5 | | | |
| Cardamine pensylvanica | 50 | 5 | | | |
| Cardamine douglassi | 10 | 4 | | | |
| Rubus idaeus | 30 | 3 | | | |
| Maianthemum canadense | 20 | 3 | | | |
| Solidago spp. | 30 | 3 | | | |
| Veronica peregrina | 10 | 1 | | | |
| Arisaema triphyllum | 10 | 1 | | | |
| Stellaria longifolia | 10 | 1 | | | |
| Sonchus arvensis | 10 | 1 | | | |
| Tovara virginiana | 10 | 1 | | | |

Table 11. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= $0.2m^2$ ) collected at GEX sites at Rondeau in spring 1992.

| Native plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | Introduced plant species and groups | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
|---|---|---|---|---|---|
| graminoids | 80 | 34 | Cardamine hirsuta | 90 | 229 |
| Cardamine pensylvanica | 70 | 25 | Taraxacum officinale | 70 | 28 |
| Bidens connata | 30 | 9 | Veronica arvensis | 70 | 11 |
| Viola spp. | 40 | 8 | Solanum nigrum | 40 | 6 |
| Arisaema triphyllum | 30 | 7 | Plantago major | 30 | 3 |
| Claytonia virginica | 30 | 6 | Veronica chamaedrys | 10 | 1 |
| Ranunculus abortivus | 10 | 4 | Sonchus arvensis | 10 | 1 |
| Pilea pumila | 30 | 4 | Stellaria media | 10 | 1 |
| Rubus idaeus | 30 | 3 | | | |
| Osmorhiza claytoni | 20 | 3 | | | |
| Galium spp. | 30 | 3 | | | |
| Oxalis montana | 20 | 2 | | | |
| Trillium spp. | 20 | 2 | | | |
| Maianthemum canadense | 20 | 2 | | | |
| Solidago spp. | 10 | 1 | | | |
| Eupatorium rugosum | 10 | 1 | | | |
| Veronica peregrina | 10 | 1 | | | |
| Podophyllum peltatum | 10 | 1 | | | |
| Epilobium glandulosum | 10 | 1 | | | |
| Circaea quadrisulcata | 10 | 1 | | | |
| Viola papilionacea | 10 | 1 | | | |
| Boehmeria cylindrica | 10 | 1 | | | |

Table 12. Species of seedlings ranked in order of frequency of emergence from n = 10 turves (total area= $0.2m^2$ ) collected at GEX GR sites at Rondeau in spring 1992.

| **Native plant species and groups** | | | **Introduced plant species and groups** | | |
|---|---|---|---|---|---|
| | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ | | Presence (% of sites sampled) | # of seedlings /$0.2m^2$ |
| graminoids | 70 | 82 | Cardamine hirsuta | 100 | 245 |
| Rubus idaeus | 70 | 19 | Cerastium vulgatum | 100 | 44 |
| Galium circaezans | 10 | 15 | Taraxacum officinale | 70 | 20 |
| Cardamine pensylvanica | 60 | 12 | Veronica arvensis | 50 | 12 |
| Viola spp. | 40 | 6 | Stellaria longifolia | 20 | 6 |
| Galium spp. | 50 | 5 | Solanum nigrum | 30 | 3 |
| Circaea quadrisulcata | 10 | 1 | Sonchus arvensis | 20 | 2 |
| Boehmeria cylindrica | 10 | 1 | Polygonum persicaria | 10 | 1 |
| Viola rostrata | 10 | 1 | Stellaria media | 10 | 1 |
| Galium triflorum | 10 | 1 | | | |

Table 13. Tree species occurring at sample stations (n = 10) at Point Pelée, ranked in order of frequency.

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Celtis occidentalis L. | 100 | 101 |
| Tilia americana | 50 | 16 |
| Quercus muehlenbergii | 40 | 10 |
| Ostrya virginiana (Mill) K. Koch | 10 | 6 |
| Quercus rubra | 20 | 5 |
| Quercus velutina | 10 | 3 |
| Prunus virginiana | 20 | 2 |
| Ptelea trifoliata L. | 30 | 2 |
| Juglans nigra L. | 20 | 2 |
| Quercus alba | 10 | 1 |
| Morus spp. | 10 | 1 |

Table 14. Tree species occurring at sample stations (n = 10) at Hillman Sandhills, ranked in order of frequency.*

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Acer saccharinum | 100 | 41 |
| Sassafrass albidum | 90 | 37 |
| Quercus rubra | 50 | 18 |
| Liriodendron tulipifera L. | 60 | 13 |
| Fagus grandifolia | 40 | 10 |
| Cornus florida | 40 | 9 |
| Quercus alba | 30 | 7 |
| Prunus serotina | 40 | 6 |
| Populus grandidentata | 20 | 4 |
| Morus spp. | 10 | 1 |
| Ulmus rubra | 10 | 1 |

*Data missing for 3 trees at station #8

Table 15. Tree species occurring at sample stations (n = 10) in grazed areas of Rondeau (adjacent to NEX sites), ranked in order of frequency.

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Fagus grandifolia | 80 | 33 |
| Ostrya virginiana (Mill) K. Koch | 60 | 26 |
| Acer saccharinum | 30 | 16 |
| Sassafrass albidum | 40 | 14 |
| Liriodendron tulipifera L. | 50 | 14 |
| Fraxinus americana | 40 | 12 |
| Carpinus caroliniana | 50 | 9 |
| Tilia americana | 40 | 9 |
| Quercus rubra | 30 | 3 |
| Fraxinus pennsylvanica | 10 | 3 |
| Carya ovata | 10 | 2 |
| Ulmus rubra | 20 | 2 |
| Quercus macrocarpa | 10 | 1 |
| Quercus alba | 10 | 1 |
| Acer rubrum | 10 | 1 |
| Prunus serotina | 10 | 1 |
| Quercus muehlenbergii | 10 | 1 |
| Fraxinus nigra | 10 | 1 |
| Pinus strobus | 1 | 1 |

Table 16. Tree species occurring at sample stations (n = 5) in Bennett exclosure at Rondeau, ranked in order of frequency.

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Acer saccharinum | 100 | 17 |
| Fraxinus pennsylvanica | 100 | 10 |
| Fraxinus americana | 60 | 9 |
| Tilia americana | 40 | 9 |
| Carpinus caroliniana | 60 | 6 |
| Lindera benzoin | 40 | 2 |
| Ulmus rubra | 20 | 2 |
| Liriodendron tulipifera L. | 20 | 2 |
| Fagus grandifolia | 10 | 1 |
| Ostrya virginiana (Mill) K. Koch | 10 | 1 |

Table 17. Tree species occurring at sample stations (n = 5) in grazed areas adjacent to Bennett exclosure at Rondeau, ranked in order of frequency.

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Tilia americana | 80 | 10 |
| Liriodendron tulipifera L. | 60 | 10 |
| Acer saccharinum | 80 | 9 |
| Fagus grandifolia | 60 | 9 |
| Fraxinus americana | 60 | 7 |
| Fraxinus pennsylvanica | 40 | 6 |
| Ulmus rubra | 60 | 5 |
| Ostrya virginiana (Mill) K. Koch | 20 | 3 |
| Ulmus americana ? | 20 | 1 |

Table 18. Shrub species occurring at sample stations (n = 10) at Point Pelée, ranked in order of frequency.

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Rubus allegheniensis | 70 | 31 |
| Celtis occidentalis L. | 70 | 28 |
| Prunus virginiana | 70 | 27 |
| Ribes cynosbati | 60 | 24 |
| Prunus serotina | 30 | 21 |
| Ptelea trifoliata L. | 40 | 11 |
| Acer saccharinum | 10 | 5 |
| Tilia americana | 10 | 2 |
| Smilax tamnoides L. var. hispida | 10 | 1 |

Table 19. Shrub species occurring at sample stations (n = 10) at Hillman Sandhills ranked in order of frequency.*

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Acer saccharinum | 90 | 48 |
| Prunus serotina | 60 | 23 |
| Sassafrass albidum | 80 | 20 |
| Fagus grandifolia | 40 | 15 |
| Cornus florida | 30 | 14 |
| Quercus rubra | 60 | 9 |
| Fraxinus americana | 40 | 6 |
| Cornus alternifolia | 30 | 4 |
| Crataegus spp. | 10 | 3 |
| Tilia americana | 10 | 1 |
| Lindera benzoin | 10 | 1 |

*Data missing for 3 shrubs at each of stations #8 and #10

Table 20. Shrub species occurring at sample stations (n = 10) in the grazed areas of Rondeau (adjacent to NEX sites), ranked in order of frequency.

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Acer saccharinum | 40 | 32 |
| Ostrya virginiana (Mill) K. Koch | 70 | 26 |
| Lindera benzoin | 20 | 25 |
| Fagus grandifolia | 40 | 24 |
| Carpinus caroliniana | 60 | 17 |
| Prunus serotina | 10 | 9 |
| Berberis thunbergii | 20 | 6 |
| Fraxinus americana | 30 | 4 |
| Fraxinus pennsylvanica | 20 | 3 |
| Betula alleghaniensis | 20 | 2 |
| Tilia americana | 20 | 2 |

Table 21. Shrub species occurring at sample stations (n = 5) in Bennett exclosure at Rondeau, ranked in order of frequency.

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Lindera benzoin | 100 | 38 |
| Sambucus canadensis | 20 | 9 |
| Fraxinus pennsylvanica | 60 | 5 |
| Rubus idaeus | 40 | 3 |
| Alnus serrulata? | 20 | 1 |
| Carpinus caroliniana | 20 | 1 |
| Liriodendron tulipifera | 20 | 1 |
| Berberis thunbergii | 20 | 1 |
| Rubus allegheniensis | 20 | 1 |

Table 22. Shrub species occurring at sample stations (n = 5) in grazed areas adjacent to Bennett exclosure at Rondeau, ranked in order of frequency.

| | Presence (% of stations sampled) | Total number of individuals |
|---|---|---|
| Lindera benzoin | 80 | 17 |
| Acer saccharinum | 80 | 16 |
| Berberis thunbergii | 80 | 15 |
| Fagus grandifolia | 20 | 6 |
| Ulmus rubra | 40 | 2 |
| Carya ovata | 40 | 2 |
| Tilia americana | 20 | 1 |
| Carpinus caroliniana | 20 | 1 |